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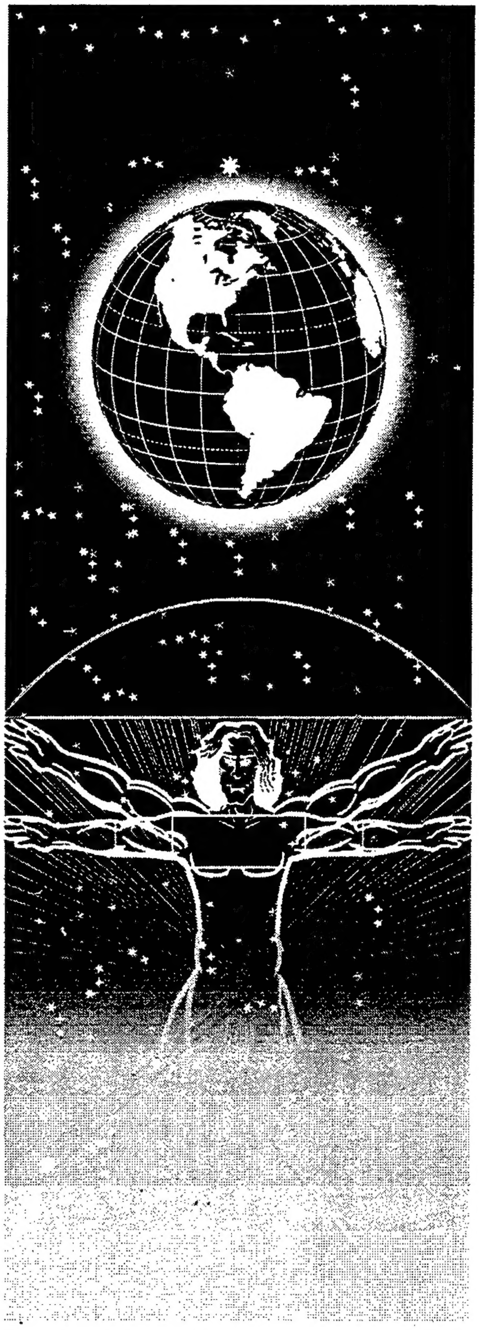

UNITED STATES AIR FORCE
IERA

Hexavalent Chromium (CrVI) Field Analytical Method for Bioenvironmental Engineers

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April 1999

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13. ABSTRACT *(Maximum 200 words)*
The Industrial Hygiene Branch, in a collaborative effort with the National Institute for Occupational Safety and Health (NIOSH), developed a field analytical method to measure hexavalent chromium (CrVI, chromate) levels in air. The method uses ultrasonic extraction of sampling filters, solid-phase extraction of chromates from the extracted solution, and determination of chromate concentrations by spectrophotometry. It is an alternative to NIOSH Methods 7300 and 7600 and overcomes some of the disadvantages of these methods. The chromate field method is relatively easy to use, specific for CrVI, has a lower detection limit than NIOSH 7600, and allow analysis before there is a chance for significant sample degradation. The method is intended for use by Bioenvironmental Engineers. Although all Bioenvironmental Engineering shops will benefit from use of the method, those shops that take a lot of chromate samples or have significant chromate exposure problems will derive the most benefit from the method.

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HEXAVALENT CHROMIUM (Cr^{VI}) FIELD ANALYTICAL METHOD FOR BIOENVIRONMENTAL ENGINEERS

INTRODUCTION

The Chromate Field Analytical Method measures hexavalent chromium (Cr^{VI}, chromate) levels in air. It was developed in a collaborative effort between the Industrial Hygiene Branch of the Institute for ESOH Risk Analysis (IERA) and the National Institute for Occupational Safety and Health. It is an alternative to NIOSH Methods 7300 and 7600 [1,2] and overcomes some of the disadvantages of these methods. NIOSH 7300 is not specific for Cr^{VI} and therefore requires a worst-case assumption that all detected chromium is in the hexavalent state [3]. NIOSH 7600 is specific for Cr^{VI}, but has a relatively high analytical detection limit and has numerous interference problems if other heavy metals are present in the sample. In addition, Cr^{VI} air filter samples are unstable over time. The requirement to submit NIOSH 7600 samples to an analytical laboratory will result in conversion of collected Cr^{VI} to Cr^{III} with a subsequent underestimation of worker exposure. The chromate field method is specific for Cr^{VI}, has a lower detection limit than NIOSH 7600, and allows analysis before there is a chance for significant sample degradation [4]. The Chromate Field Method will be a numbered NIOSH method included in the next supplement to the NIOSH Manual of Analytical Methods.

The method is intended for field use by Bioenvironmental Engineers. Appendix A lists equipment, chemicals, supplies, glassware, and personal protective equipment required to use it. The largest cost associated with the method is the equipment (spectrophotometer, sonicator, solid-phase extraction manifold, vacuum pump). For Bioenvironmental Engineering (BEE) shops that already have portable spectrophotometers and vacuum pumps associated with their water programs, the cost will be significantly less. Most BEE shops will have at least some of the supplies, glassware, and protective equipment already on-hand. Be aware that NIOSH is developing other field analytical methods which will use the same equipment as the Chromate Field Method.

Although all BEE shops will benefit from the method, those shops that take a lot of chromate air samples or have significant chromate exposure problems will derive the most benefit from the method. You may want to use NIOSH 7300, which gives a worst-case chromate concentration, to screen for chromate problems. If NIOSH 7300 indicates you either don't have a chromate problem or that your chromate exposures are extremely elevated (such as during priming with a chromated primer), then further sampling with the Chromate Field Method may be superfluous. However, if you have chromate exposures on the exposure limit borderline that are driving respiratory protection and physical examination requirements, then the Chromate Field Method will help you get a better handle on the extent of your chromate problems.

PRELIMINARY INFORMATION

Safety Precautions

Samples collected in the industrial shop area should be analyzed in a clean area, such as the Bioenvironmental Engineering Shop. Hexavalent chromium is a human respiratory carcinogen [5], so make efforts to prevent aerosolizing chromate-containing compounds and solutions. Carry out all sample preparation in a well-ventilated area. Handle acetonitrile solutions carefully because they are very volatile. Ensure appropriate chemical storage areas are available. Do not store acids with bases and secure all chemicals. When using the method, wear a lab coat, safety glasses, and disposable nitrile rubber gloves.

Laboratory Protocols

Read and follow the instructions for the pipette, sonicator, solid-phase extraction unit, vacuum pump, and spectrophotometer. It is best to become thoroughly familiar with how the equipment operates before attempting to run the method. Practice pipetting technique to ensure proper volumes are delivered into solution. Some equipment requires routine maintenance, such as the spectrophotometer (checking the lamp) and the pipettes (replacing gaskets and calibration). Consult the equipment manuals for specific maintenance requirements. Empty the sonicator bath of water after use and wipe it out to avoid rusting the metal reservoir.

Properly clean glassware used during the method after use. Clean glassware with detergent, scrub using non-metal brushes, triple rinse with tap water, then triple rinse with distilled/ deionized water. Finally, dry glassware on a drying rack or in a drying oven. Careful attention to glassware washing will ensure samples are not inadvertently contaminated.

When diluting chemicals to a volumetric marker on a container, read the bottom of the meniscus. Always label every container to avoid confusion. Refrigerate stock solutions between use, as they are good for *two weeks* only.

Make provisions for disposal of chromium containing samples and solutions. They may be considered hazardous waste at your location. One possible disposal location is your Structural Maintenance Facility, which probably has a chromate waste stream, and may or may not be compatible with this procedure's waste stream. Excess acids and bases should be diluted with a large volume of cold water before disposal.

SAMPLING METHODOLOGY

Particle Size Considerations

Evaluate the work environment and sample for chromates as described in IERA/RSHI Consultative Letter AL-OE-BR-CL-1998-0047, *Industrial Hygiene Sampling Guidance* [3]. Specifically, consider the particle size encountered in the workplace. For example, welding operations may be sampled in a closed-face mode. Samples collected during sanding, priming, and painting should be collected in open-face mode using a cassette holder designed to hold the face of the cassette parallel to the worker's body. To collect the inhalable mass fraction and reduce sampling bias from the particle size distribution, drill a 15-mm hole in the top of the inlet cap [6].

Sampling Filters

Sampling for hexavalent chromium using either 5-μm polyvinylchloride (PVC) or 0.8-μm mixed cellulose ester (MCE) filters, mounted with backup pads in a 37-mm 3-piece polystyrene cassette. MCE filters, and some PVC filters, promote reduction of Cr^{VI} to Cr^{III}. This reduction, however, occurs on a time scale of a few days, so either filter type is acceptable for field use if analyzed within 24 hours of collection. Alternative filters such as polytetrafluorinated ethylene (PTFE, Teflon®), binder-free glass fiber filters, or quartz fiber filters may also be used. Filters can be pretreated with a base to minimize Cr^{VI} reduction when sampling in high-iron or acidic environments [7].

Sample Flow Rates/Volumes

Calibrate each personal sampling pump with representative sampling media in the line using a vacuum chamber. Sample in the worker's breathing zone at an accurately known flow rate in the range of 1-4 liters per minute (lpm) for a sample volume of 100-1000 liters. Our recommended flow rate is 2.0 lpm. Estimate the particulate loading and do not exceed 2 mg of particulate loading on the filter, if possible. After sampling, remove the pump and sample media from the worker. Label the filter cassette. Take several filter cassettes to the workplace to serve as analysis blanks.

PREPARATION OF REAGENTS

NOTE
Don personal protective equipment and prepare solutions in a vent/lab hood.

NOTE
Make sure all solutions are at room temperature to aid in accurate measurement. Use a disposable funnel when preparing these solutions. Adding granules alternatively with water will aid the dissolving process.

Weak Buffer

0.05M ammonium sulfate/0.05M ammonium hydroxide: Weigh out 1.652 g of ammonium sulfate, put into a 250-ml volumetric flask, and pipet 2.5-ml of ammonium hydroxide into the flask. Dilute to the 250-ml line (reading the bottom of the meniscus) with distilled water. Cap before removing from vent hood.

Strong Buffer

0.5M ammonium sulfate/0.1M ammonium hydroxide: Weigh out 16.52 g of ammonium sulfate, put into a 250-ml volumetric flask, and pipet 5.0-ml of ammonium hydroxide into the flask. Dilute to the 250-ml line (reading the bottom of the meniscus) with distilled water and cap.

NOTE
Put the flask in the sonicator if the granules aren't going into solution. Constantly turn to ensure all granules are dissolved.

Complexation Reaction Solution

Mix in a light-sensitive volumetric flask (e.g., amber). Weigh out 0.48g diphenylcarbazide (DPC) powder. Put into a 100-ml volumetric flask alternately with acetonitrile, stirring as the DPC powder is added. To ensure accuracy, make sure all DPC powder is dissolved prior to reaching 100-ml line with acetonitrile. Fill to the 100-ml line with acetonitrile (read the bottom of the meniscus).

NOTE
Put the flask in the sonicator if the powder isn't dissolving into solution. Be careful though – **acetonitrile is volatile**!

Cr^{VI} Calibration Stock Solution

Prepare by diluting a 1000 μg/ml Cr^{VI} commercial standard. Pipet 10-ml Cr^{VI} commercial standard into a 100-ml volumetric flask and dilute to the 100-ml mark with distilled water (read the bottom of the meniscus). This gives you a Cr^{VI} solution concentration of 100 μg/ml.

NOTE
Refrigerate solutions (good for 2 weeks only).

CALIBRATION

Purpose

Calibrating the spectrophotometer allows an absorbance versus concentration curve to be drawn. The absorbance curve is proportional to the concentration of Cr^{VI} in the solution extracted from your sampling filters. You'll use this curve to determine the amount of Cr^{VI} that was collected on the filter. Calibrate the spectrophotometer with at least 8 working standards plus a blank, over the range of 0-3 μg/ml of Cr^{VI}. Analyze at least three of the calibration solutions in triplicate for quality assurance purposes.

Preparation of Calibration Solutions

Prepare chromate calibration solutions in concentrations from 0 μg/ml (blank) to 3.0 μg/ml. Pipet the amounts of concentrated hydrogen chloride (HCl), Cr^{VI} calibration stock solution, and complexation reaction solution (DPC) shown in Table 1 into a test tube, then fill to the 10-ml mark with strong buffer (see Figure 1).

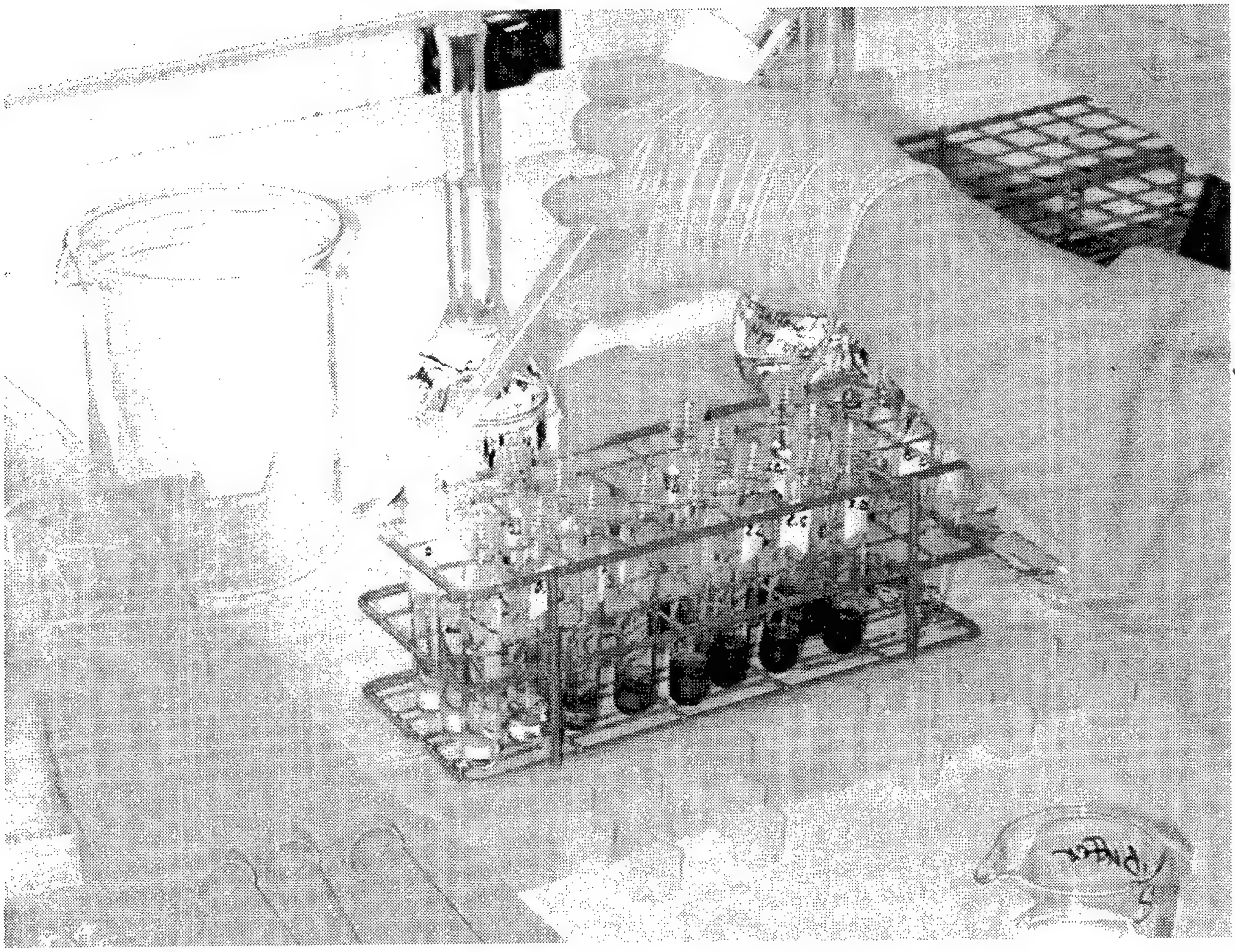
> **NOTE**
> Use a separate pipette tip for each solution and for each concentration. Avoid cross-contaminating the solutions. The solutions in the centrifuge tubes will turn pink once the DPC solution is added. Allow 10 minutes for each of the solutions to stabilize prior to reading the absorbance in the spectrophotometer.

> **NOTE**
> Add the solutions to a clean, dry test tube in the following order: HCl, Cr^{VI} calibration stock solution, DPC, and last, strong buffer.

Table 1. Preparation of Calibration Solutions

Cr^{VI} Concentration (μg/ml)	HCl (μl)	Cr^{VI} Stock Solution (μl)	DPC (ml)	Strong Buffer (ml)
0.0 (Blank)	100	0	2.0	7.90
0.1	100	10	2.0	7.89
0.2	100	20	2.0	7.88
0.8	100	80	2.0	7.82
1.0	100	100	2.0	7.80
1.5	100	150	2.0	7.75
2.0	100	200	2.0	7.70
2.5	100	250	2.0	7.65
3.0	100	300	2.0	7.60

Figure 1. Preparation of Calibration Solutions



Preparation of Calibration Graph

Analyze the calibration solutions and the blank with the spectrophotometer (see Figure 2) and prepare a calibration curve of absorbance vs. Cr^{VI} concentration using the following steps.

1. Turn on the spectrophotometer. After the self-test, select the number *0*, followed by the *Enter* key.

2. Set the spectrophotometer to 540 nanometers (nm).

3. Place deionized water in a test tube, load into the spectrophotometer, and cover. Select the word *Zero* to zero the instrument.

4. Load each calibration standard into the spectrophotometer (in turn) and cover (see Figure 3). Select *Read*.

NOTE
Wipe any extra moisture/liquid off the sides of the test tubes before placing in the spectrophotometer.

5. Record the absorbance value for each calibration solution.

6. After completing these steps you will have a table of absorbance versus concentration (in µg/ml). Prepare a calibration curve from your readings. An example is shown in Table 2 and Figure 4.

NOTE
If you use the method again, you can revalidate the curve by mixing and running one standard.

Figure 2. HACH DR/2010 Spectrophotometer

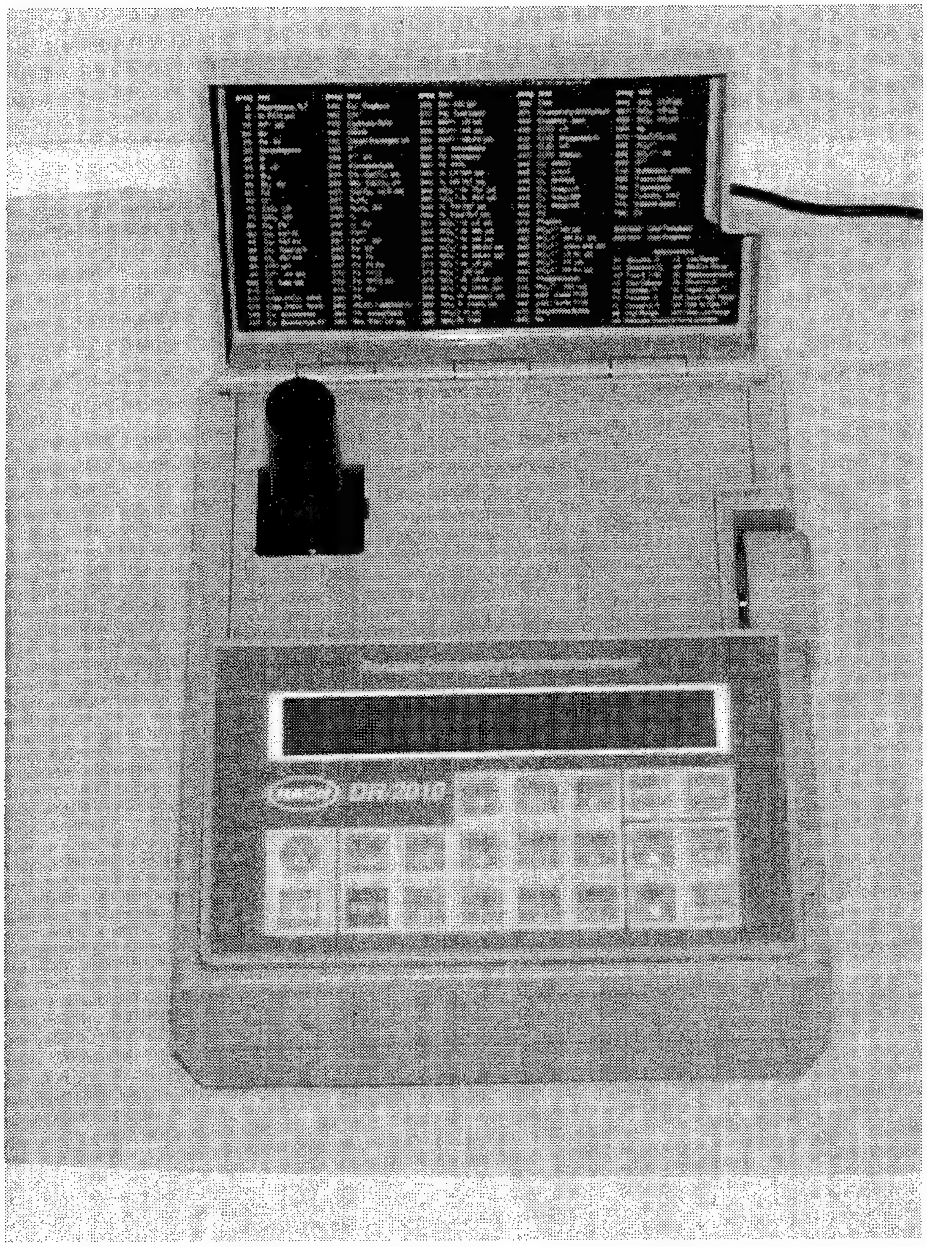


Figure 3. Reading the Calibration Solutions

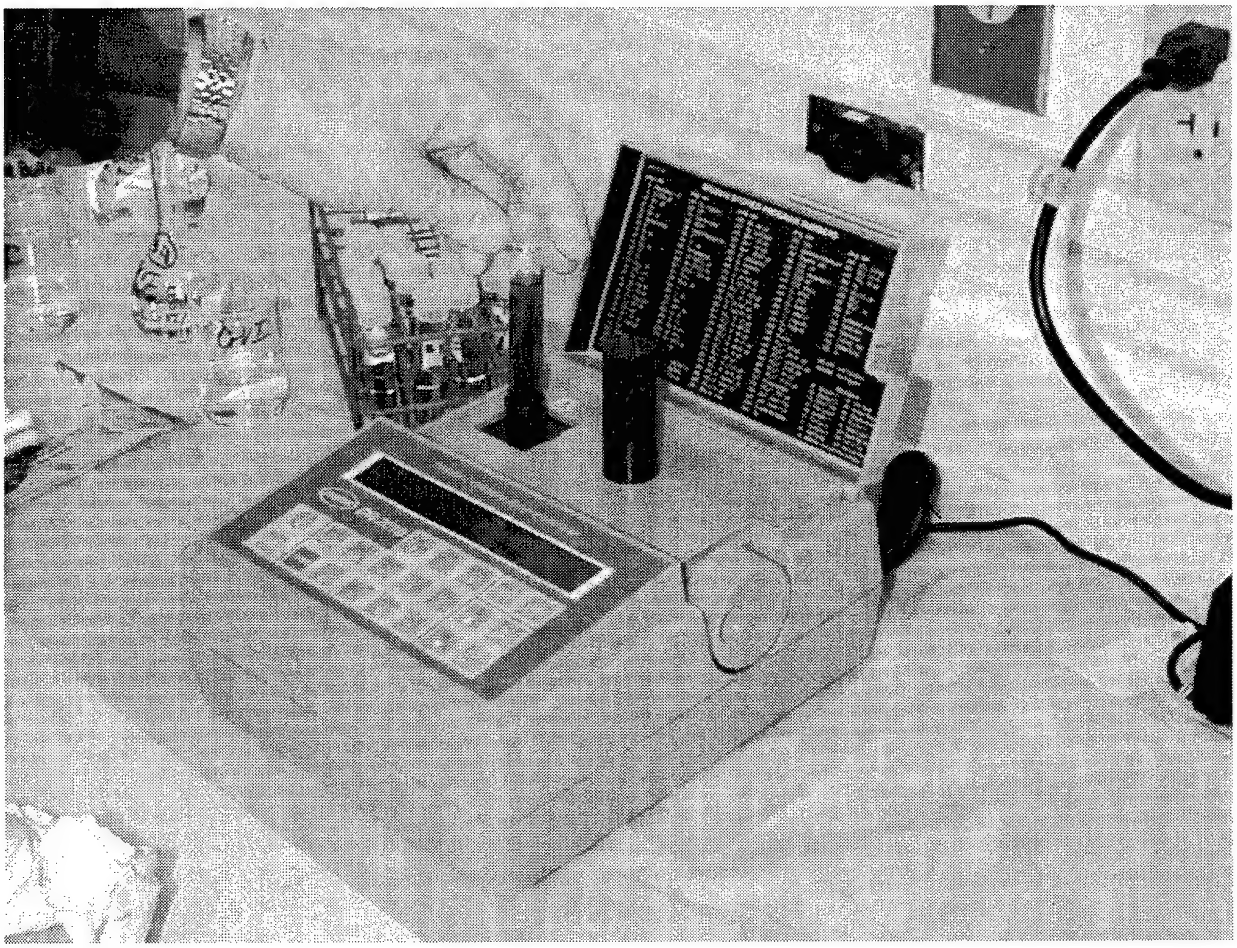
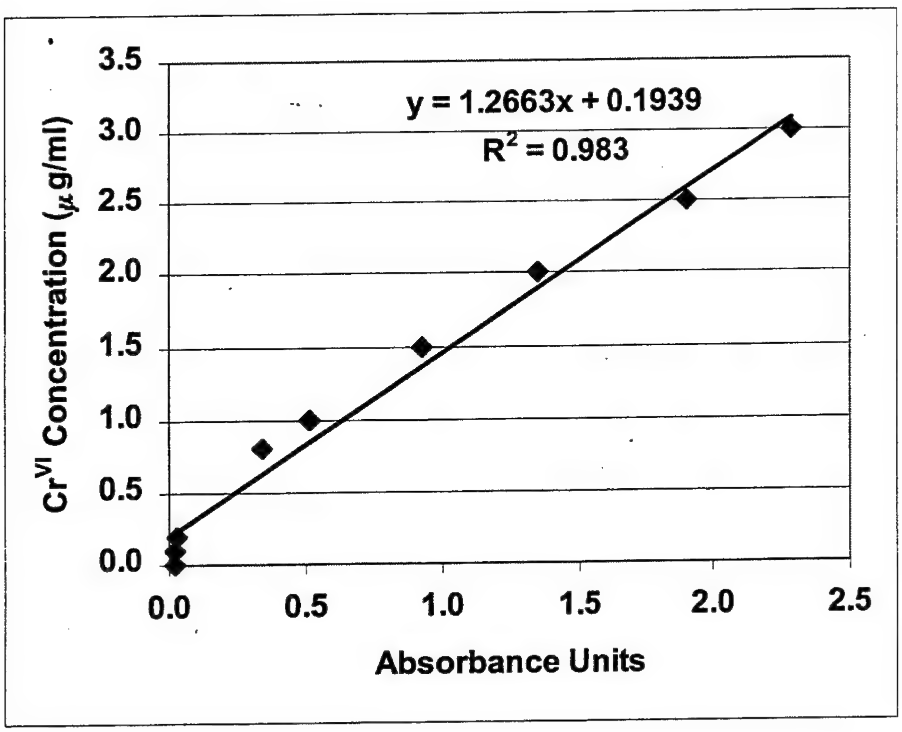


Table 2. Calibration Data (Example)

Cr^{VI} Concentration (μg/ml)	Absorbance Units
0.0	0.019
0.1	0.024
0.2	0.026
0.8	0.346
1.0	0.516
1.5	0.924
2.0	1.347
2.5	1.900
3.0	2.285

Figure 4. Calibration Curve (Example)*



*This curve is opposite the way such graphs are usually plotted. Usually, you plot the independent variable (Cr^{VI} concentration) on the X-axis and the dependent variable (Absorbance) on the Y-axis. We have reversed the order to make it the curve easier to use. When you analyze your samples, you will read absorbance from the spectrophotometer in order to find out the Cr^{VI} concentration. With the calibration curve graphed as shown, you can use the fitted equation directly ($Cr^{VI} = f$(Absorbance)).

PREPARATION AND ANALYSIS OF SAMPLES

Ultrasonic Extraction

Ultrasonification aids removal of chromium from the filters.

NOTE
Make sure the sonicator is "on" (making noise), and the heat is on at least 20 minutes prior to use. Place a beaker (or a test tube holder) filled with water in the sonicator to prevent the extraction tubes from floating around in the sonicator.

1. Don a fresh pair of disposable nitrile or latex gloves (to prevent sample contamination). Remove the filter from the cassette *within 1 hour* of completion of sampling.

2. Open the filter cassette with a cassette opener.

3. Lift the filter slightly out of cassette with clean nylon/plastic forceps or tweezers.

4. Using the forceps, carefully peel the filter off the back up pad.

5. Fold the filter and carefully insert it into a labeled 15-ml centrifuge tube. Push the filter down past the 10-ml mark on the tube.

NOTE
Labeling the centrifuge tubes before placing the filters in them will avoid confusion about sample identity.

6. Pipet 10-ml of the weak buffer into each centrifuge tube containing a filter. Ensure that the filter is covered by the buffer solution, then cap the tube.

7. Place the centrifuge tube into the beaker in the sonicator (more than one tube can be done at a time). The water level in the bath should be higher than the liquid level in the centrifuge tube (see Figure 5).

8. Repeat steps 2-8 for each sample filter.

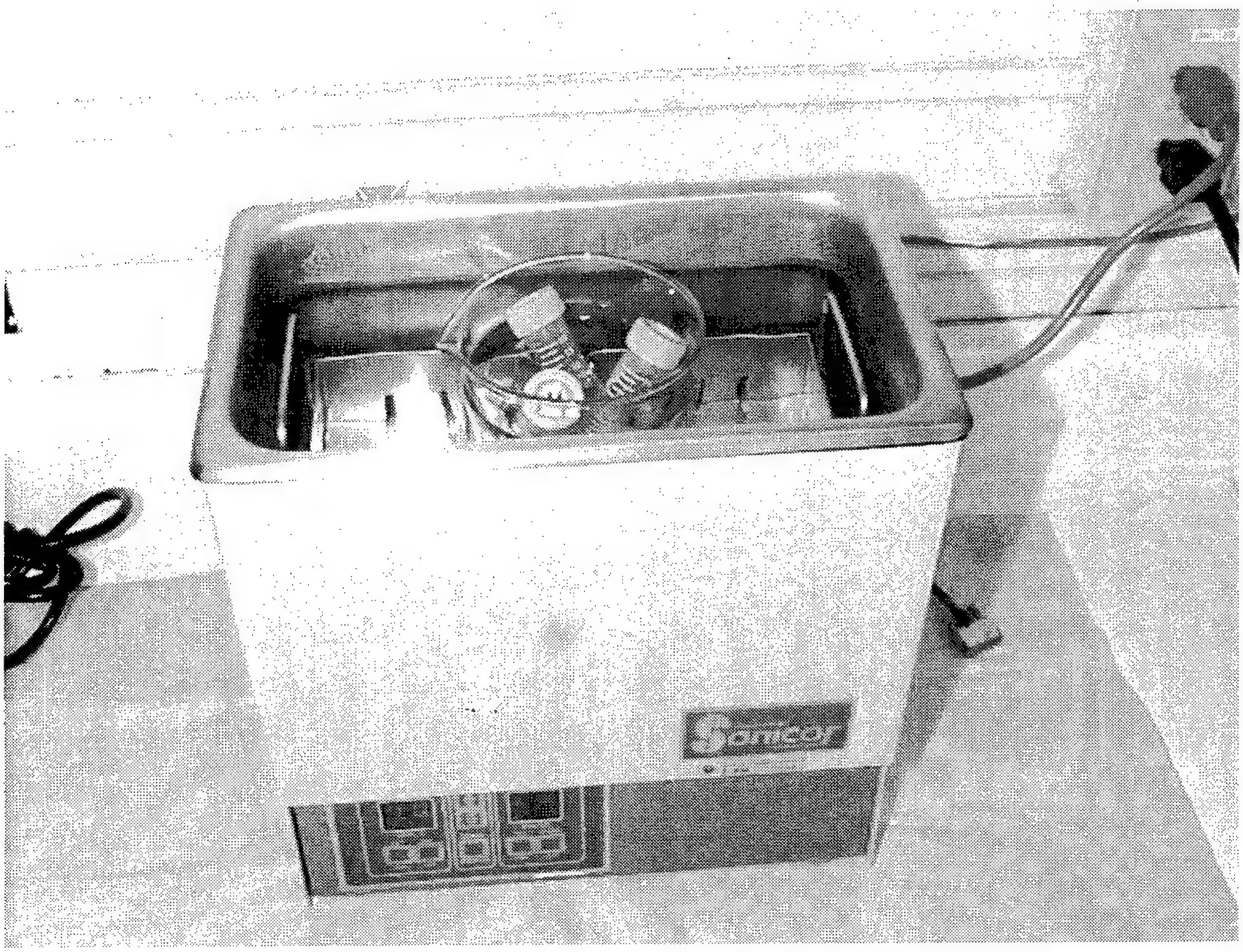
NOTE
Clean the forceps with distilled water and a Kimwipe before removing the next filter.

NOTE
Remove the blank filters in the same manner as the actual samples. Be careful not to cross-contaminate either the blanks or the sample filters.

9. Ensure the sonicator is at the proper temperature and sonicate the centrifuge tubes for 30 minutes. Place the steel basket inside the sonicator to aid in retrieving and stabilizing the samples.

10. Discard the backup pads and the gloves.

Figure 5. Ultrasonic Extraction



Solid-Phase Extraction

The solid-phase extraction procedure separates the hexavalent chromium from trivalent chromium.

1. After 30 minutes of sonication, remove the centrifuge tubes from the sonicator.

2. Set up the solid-phase extraction manifold (see Figure 6), using the disposable teflon valve liners to prevent cross-contamination. Place a sufficient number of 3-ml disposable solid-phase extraction (SPE) cartridges in the manifold port for the number of samples you have (the manifold can hold up to 12 cartridges). Place a scintillation vial inside the manifold beneath each cartridge. Label the vials.

3. Pipet 3-ml of the sonicated solution from the centrifuge tubes into the SPE cartridges (see Figure 7). Use a new pipette tip for each centrifuge tube to prevent cross-contamination.

> **NOTE**
> Use care not to spill solution out of the cartridge.

> **NOTE**
> Run replicates for at least 10% of the filter samples.

4. Attach the vacuum pump to the manifold.

> **NOTE**
> A glass flask should be placed between the SPE manifold and the vacuum pump to avoid aspiration of spilled liquids into the vacuum pump (see Figure 8).

5. Open the manifold valves all the way. Turn on the pump, and adjust the vacuum to 8" Hg. The extraction solution will drip through the SPE cartridges. This process selectively binds Cr^{VI} to the stationary phase of each cartridge.

> **NOTE**
> Do not allow the loaded SPE cartridges not drip too rapidly. Adjust the manifold valves by turning them counterclockwise, if necessary, to slow down rate of liquid dripping through the cartridges (see Figure 9).

6. When no more solution is dripping from the cartridges, increase the vacuum to ensure that all the solution has passed through the cartridges.

7. Reduce the vacuum to 0" Hg.

8. Add 3-ml distilled water to each SPE cartridge and repeat steps 5-7. This process rinses the SPE cartridges and removes impurities.

9. Repeat step 8 twice more for a total of 3 rinses (9-ml) for each cartridge. Remove the scintillation vials inside the manifold (underneath the cartridges).

> **NOTE**
> This solution contains unused extract solution. Discard as hazardous chromium waste.

10. Place clean, labeled test tubes inside the manifold beneath the SPE cartridges.

NOTE
Label the test tubes at the top of the tube to avoid interference with the spectrophotometer beam.

11. Add 3-ml of the strong buffer to each cartridge, and repeat steps 5-7. This process elutes Cr^{VI} from the cartridges and collects it in the test tubes.

12. Repeat step 11 twice more, for a total of 3 rinses (9-ml).

13. Remove the test tubes and cap them. The test tubes now contain extracted and isolated Cr^{VI}, which is ready for analysis.

14. Dispose of the used SPE cartridges and teflon valve liners. New ones will be used next time to prevent cross-contamination.

Measurement

1. Uncap a test tube containing the extracted and isolated Cr^{VI}, and add 100-µL HCl.

NOTE
Be sure to use new pipette tips for each chemical added.

2. Add 2-ml DPC complexation solution (see Figure 10). Allow the solution to stand for 10 minutes.

3. Repeat steps 1 and 2 for each tube.

4. Turn on the spectrophotometer. After the self-test, select the number *0*, followed by the *Enter* key.

5. Set the spectrophotometer to 540 nanometers (nm).

6. Place deionized water in a test tube, load into the spectrophotometer, and cover. Select the word *Zero* to zero the instrument.

7. Place the test tube containing extracted Cr^{VI} into the spectrophotometer and cover. Select *Read*.

NOTE
Wipe any extra moisture or liquid off the sides of the test tube with a Kimwipe before placing it in the spectrophotometer.

8. Record the absorbance value.

NOTE
If the absorbance value is not within your calibration range, dilute the solution being analyzed with strong buffer solution and reanalyze. Record the dilution factor so you can correct the concentration value.

9. Repeat steps 7-8 for each tube containing solution.

Figure 6. Solid-Phase Extraction Manifold

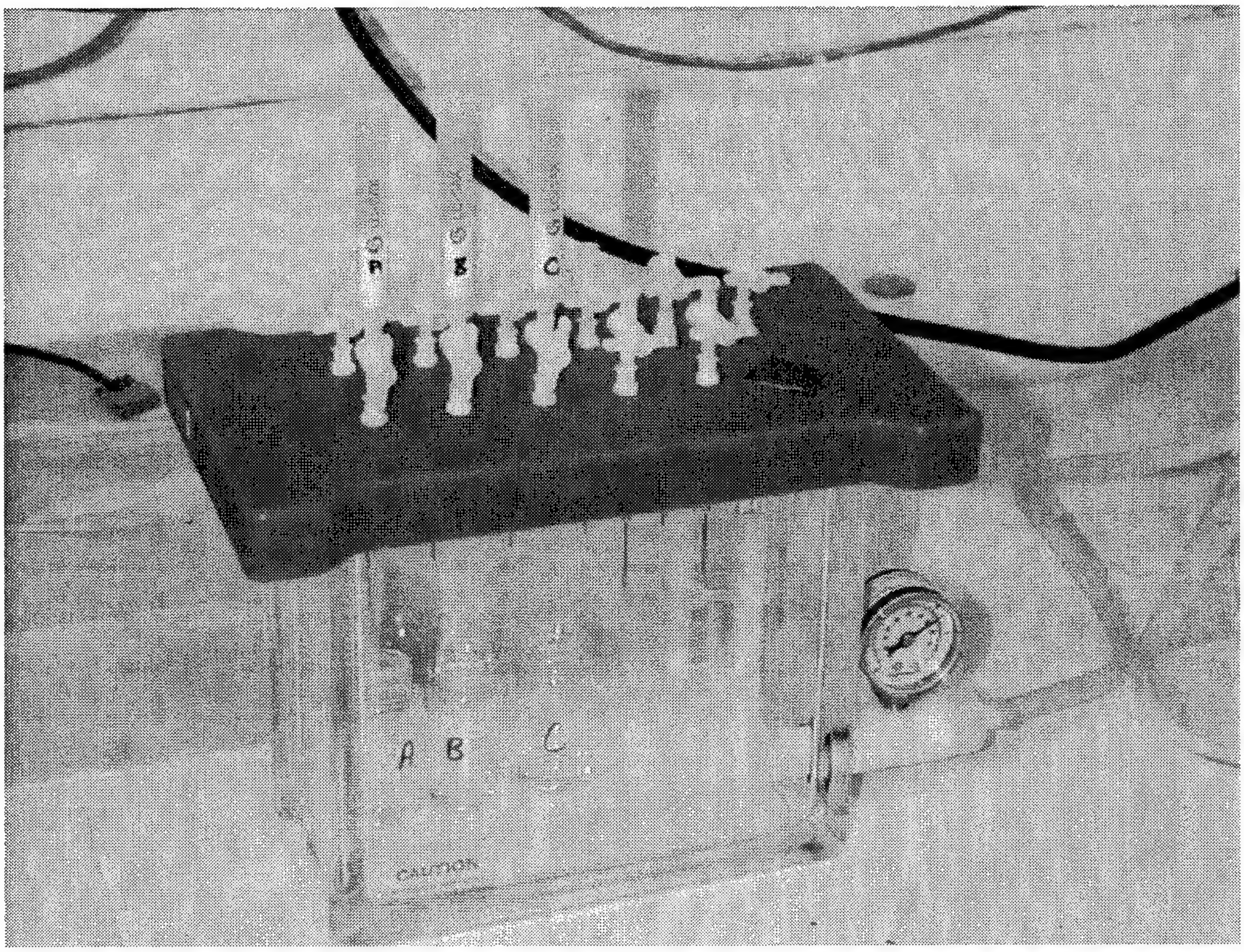


Figure 7. Placement of Sonicated Solution Into the SPE Cartridges

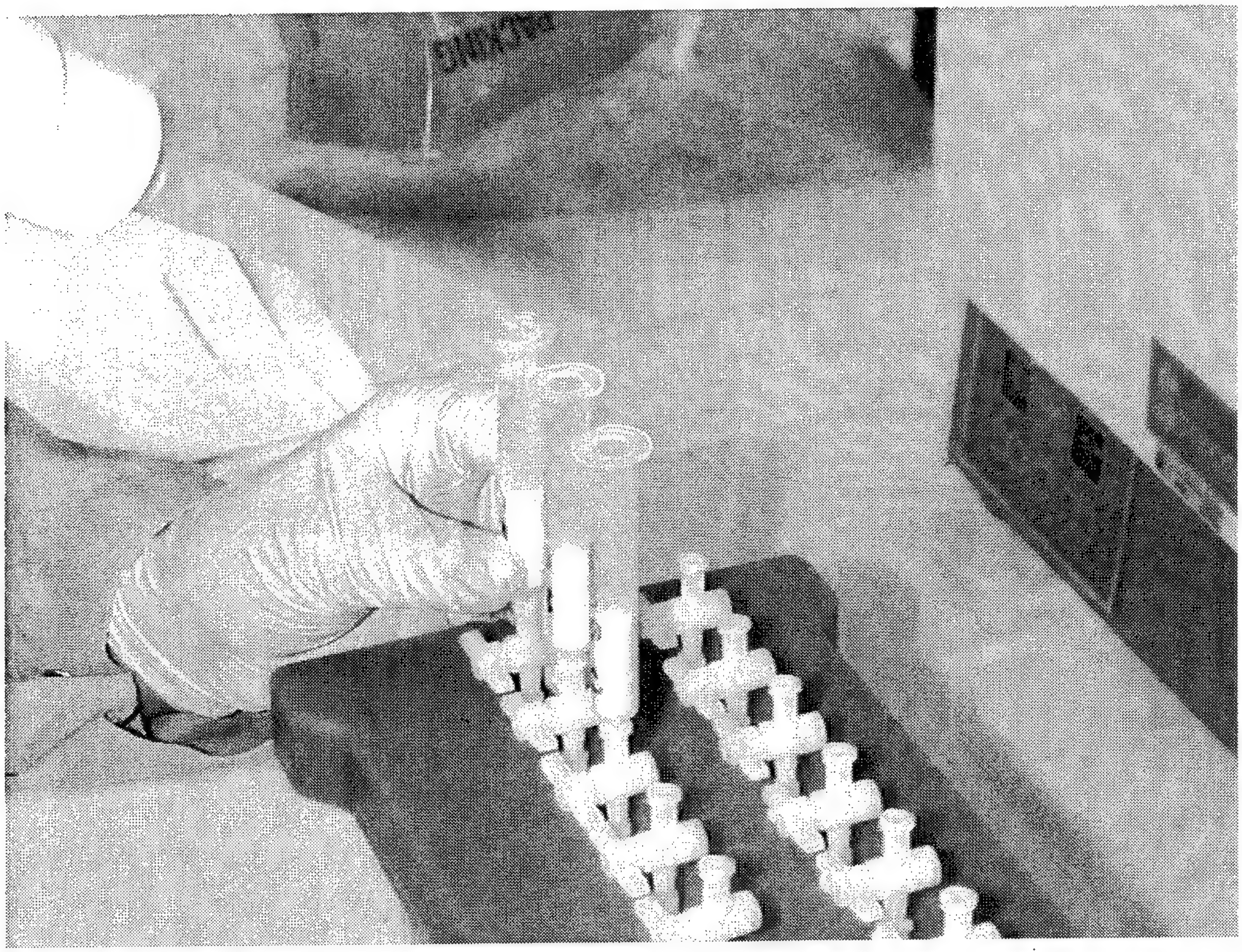


Figure 8. Extraction Manifold With Glass Flask In-Line

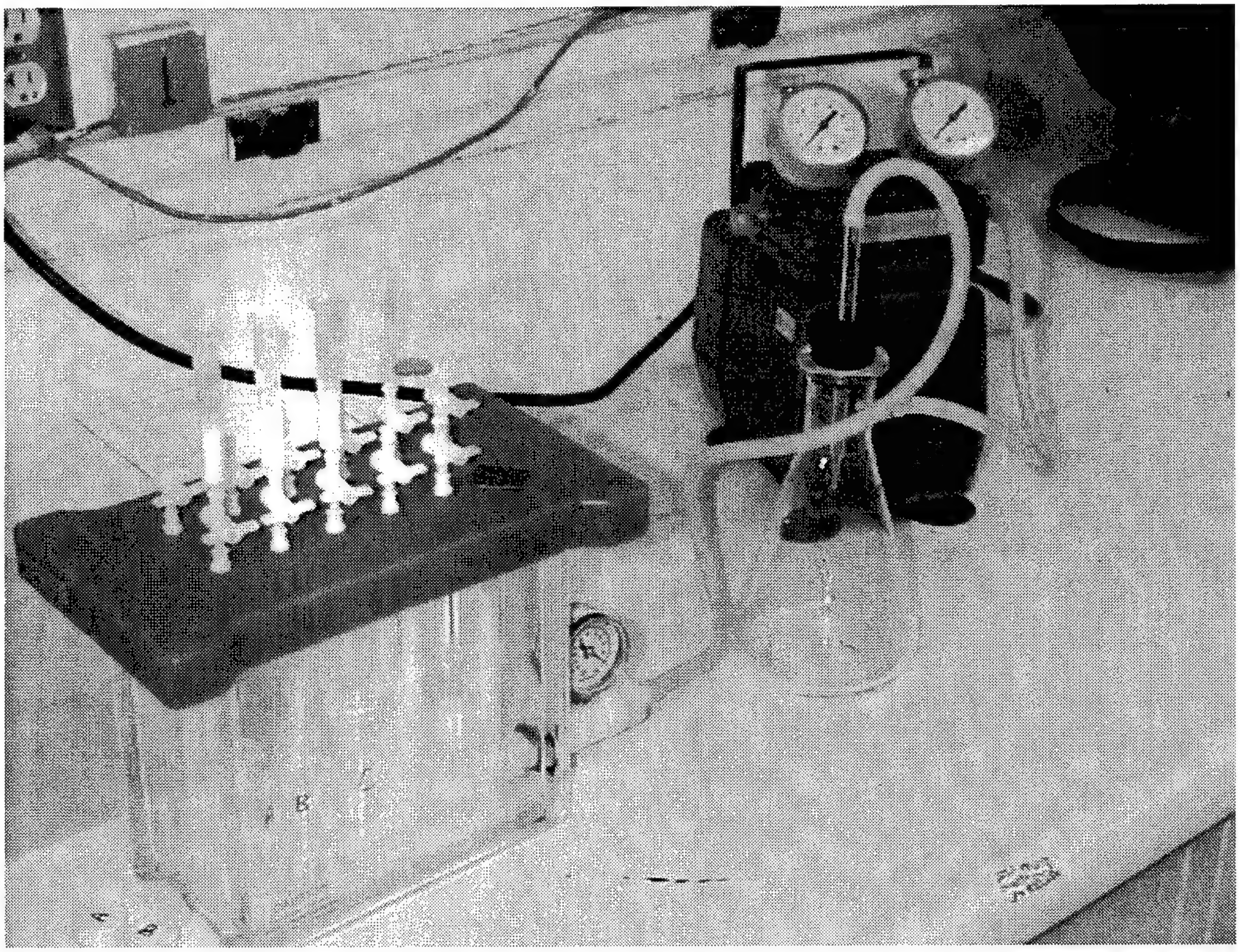


Figure 9. Adjustment of Manifold Valves

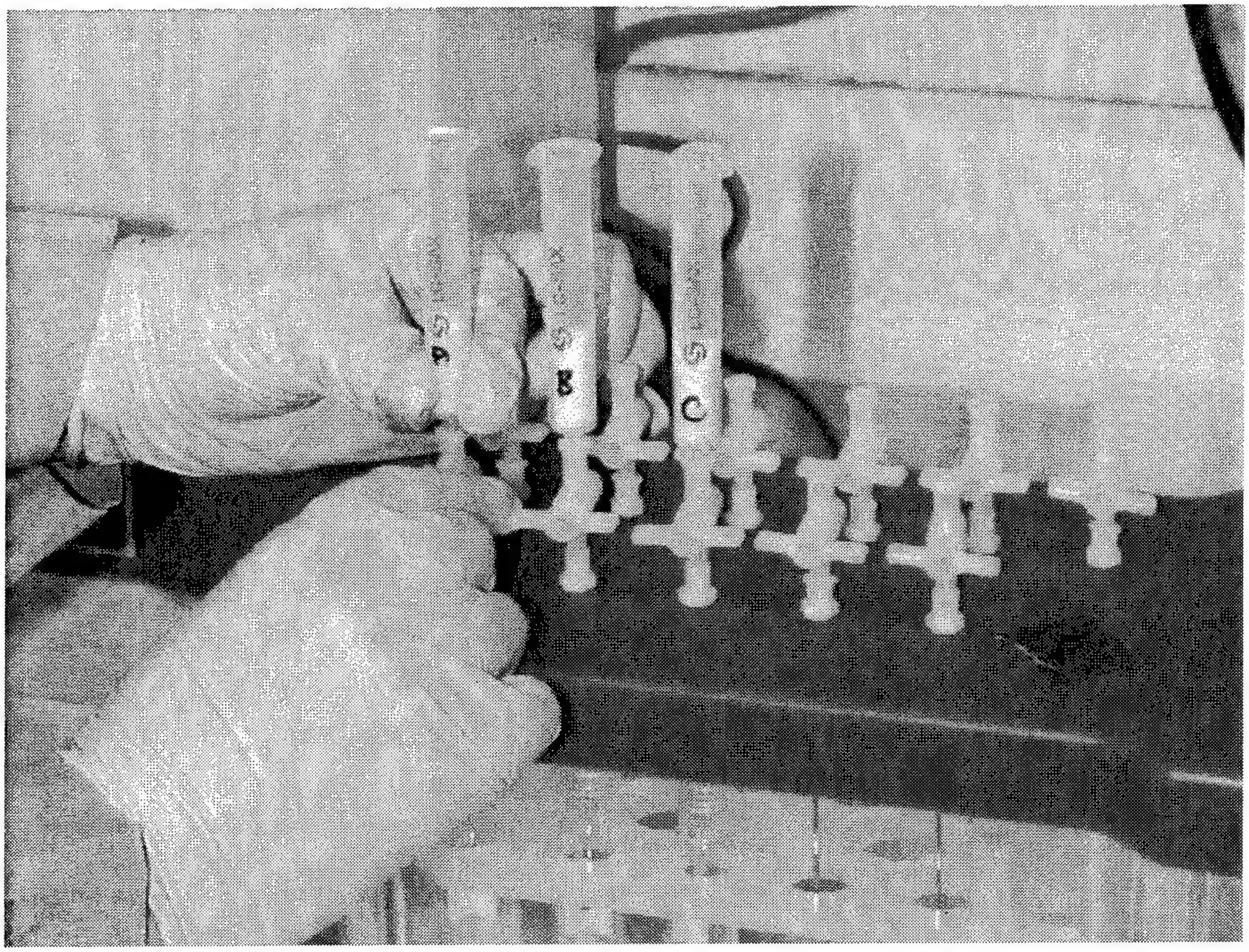
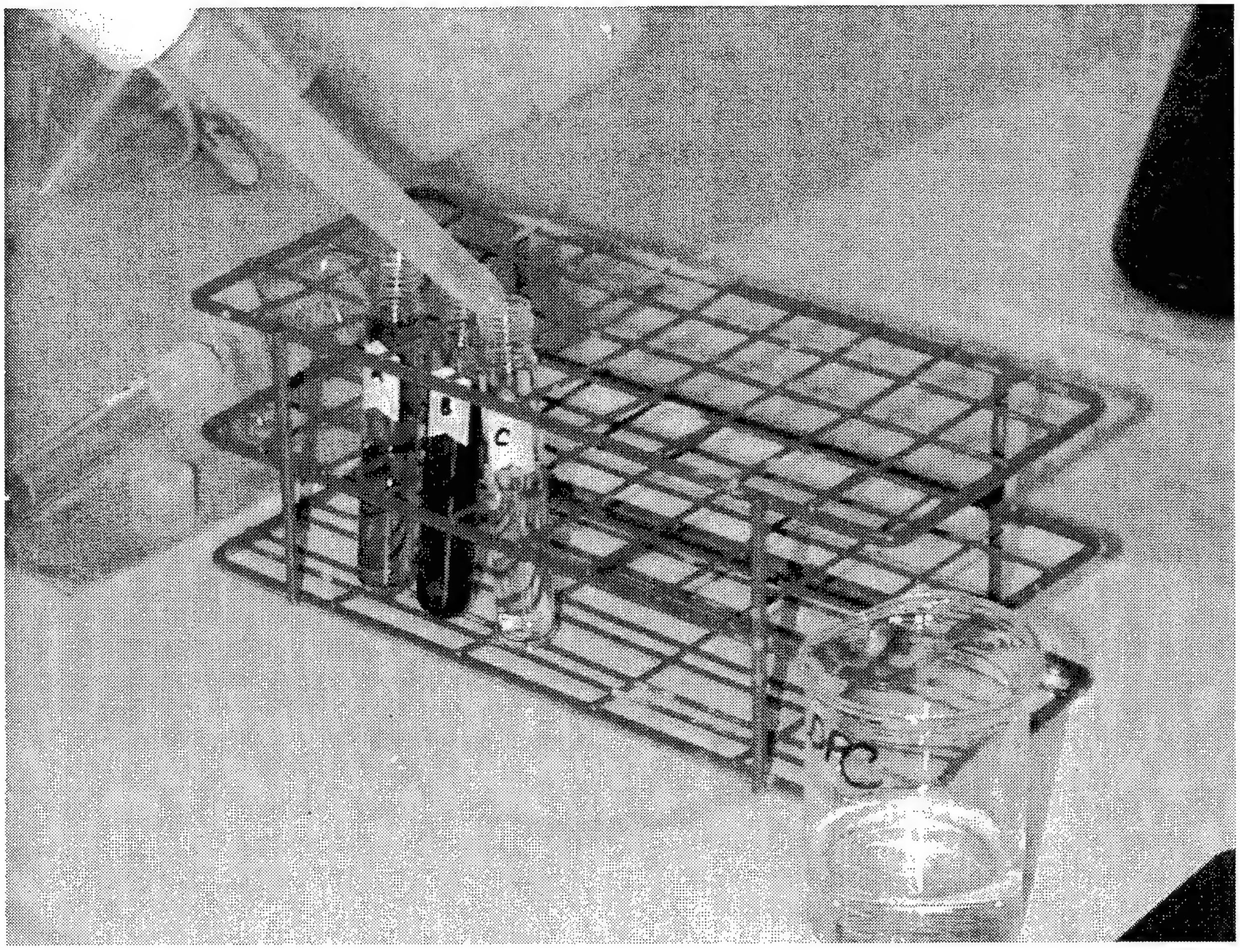


Figure 10. Adding DPC to Extracted Chromate Solutions



Determination of Concentration

1. Use the calibration curve to determine the sample solution concentration (see Appendix B for an example of how to do this).

2. Determine the mass of Cr^{VI} in the each sample and blank using the following formulas:

$$\text{Weight} = [Cr^{VI}]\frac{(\text{Volume of calibration solution})(\text{Volume of extracted solution})}{(\text{Volume of sonicated sample})}$$

$$W = [Cr^{VI}]\,\frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

$$B = [Cr^{VI}]\,\frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

where

$[Cr^{VI}]$ = Cr^{VI} concentration in extracted solution (µg/ml)
W = mass of Cr^{VI} in sample (µg)
B = mass of Cr^{VI} in blank (µg)

3. Determine the airborne concentration of Cr^{VI} in your samples using the following formula:

$$C = \frac{(W - B)}{V}$$

where

C = Air concentration of Cr^{VI} (mg/m^3)
V = Sample volume (liters)

4. If you had to dilute your extracted solution because you were outside of your calibration range, you will have to account for this dilution in step 2, above.

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Appendix A – Required Materials

Table A-1. Equipment Required for Chromate Field Method

Product	Description	Suggested Supplier	Catalog #	Price
Ultrasonic cleaner	Solid state with digital timer and temperature control	Sonicor Instruments Corporation 100 Wartburg Ave Copiague, NY 11726 (516) 842-3344	DSC-101TH	$ 520.00
Ultrasonic cleaner basket	For use with sonicator	Sonicor Instruments	Model B-101	$ 40.00
Solid-phase extraction manifold	12-port manifold with disposable liner	Supelco Inc Bellefonte, PA (800) 359-3041	5-7044	$ 550.00
Portable vacuum pump	With pressure metering gauge to 60psig, 115V/60Hz	Fisher	01-092-29	$ 316.16
DR/2010 Spectrophotometer		HACH Company P.O.Box 608 Loveland, Colorado 80539 (800) 227-4224	49300-00	$ 1,595.00
			Total Cost:	**$ 3,021.16**

Table A-2. Chemicals Required for Chromate Field Method

Product	Size	Suggested Supplier	Catalog #	Price
Ammonium sulfate, ACS	500 g	BVA Scientific P.O. Box 691468 San Antonio, TX 78269 (210) 699-0032	0792-01/BC	$ 17.45
Ammonium hydroxide, ACS	2.5 l	BVA Scientific	9721-04/BC	$ 19.82
1,5-Diphenylcarbazide (DPC)	25 g	BVA Scientific	K620-03/BC	$ 47.36
Hydrochloric acid, ACS	2.5 l	BVA Scientific	9530-33/BC	$ 29.40
Acetonitrile, ACS	4 l	BVA Scientific	9011-03/BC	$ 95.90
Single element standard, $K_2Cr_2O_7$, as Cr^{+6}	500 ml	High Purity Standards PO Box 80609 Charleston, SC 29416 (843) 556-3411	100012-7	$ 57.00
Reagent grade water, distilled	4 l	Fisher Scientific P.O. Box 869022 Plano, TX 7086-9022 1-800-766-7000	W2-4	$ 24.10
Glassware detergent (Alconox)	50x1/2 oz	Fisher Scientific	04-322-5A	$ 16.00
			Total Cost:	**$ 307.03**

Table A-3. Supplies Recommended for Chromate Field Method

Product	Description/Size	Suggested Supplier	Catalog #	Price
Adjustable pipettor	1 - 10 ml	Fisher PO Box 1307 Houston, TX 77251 (800) 766-7000	21-100	$ 240.00
Adjustable pipettor	10 - 100ml	Fisher	21-247	$ 216.00
Adjustable pipettor	100 - 1000ml	Fisher	21-249	$ 216.00
Pipet tips	1 - 10ml, 250/pk	Fisher	21-196-1	$ 34.00
Pipet tips	1 - 200ml, 1000/pk	Fisher	NC9114143	$ 34.40
Pipet tips	201 - 1000ml, 1000/pk	Fisher	22256504	$ 31.42
Polypropylene centrifuge tubes	17x120mm/15ml graduated tubes with screw caps, 500/pk	Fisher	14-959-49B	$ 134.20
Chemware forceps	Teflon-coated tips	Fisher	10-317-10	$ 11.38
Kimtex heavy duty wipers	Pop-up box,3 boxes/cs	Fisher	06-665-21A	$ 76.00
Distilled water wash bottles	500ml, 6/pk	Fisher	03-409-23G	$ 21.17
Polypropylene beakers	Set of 5, one each of 50, 100, 250, 500 and 1000ml	Fisher	02-591-16	$ 20.03
Polystyrene weighing boats	Standard, 500/pk	Fisher	02-204B	$ 50.86
Ellipso-spoon spatula	5-7/8" length	Fisher	14-375-55	$ 13.50
Polyurethane tubing	Nalgene, 50'/pk	Fisher	14-176-172	$ 38.75
Beaker brush	Soft, non-metal brushes	Fisher	03-555	$ 11.13
Flask brush	250ml with plastic handle	Fisher	03-570A	$ 6.56
Drying rack	Polystyrene with 72 pegs	Fisher	05-718-40	$ 171.24
Nalgene test tube rack	For 16mm tubes	Fisher	14-809-43	$ 13.74
Disposable teflon valve liners	100/pk	Supelco	May-59	$ 35.00
Strong anion exchange (SAX) solid phase extraction (SPE) cartridges	3ml/500mg quaternary amine bonded silica for use with 12-port manifold	Varian Sample Prep Products 24201 Frampton Ave. Harbor City, CA 90710 1-800-421-2825	12132044	$ 130.00
			Total Cost:	**$ 1,505.38**

Table A-4. Glassware Recommended for Chromate Field Method

Product	Description/Size	Suggested Supplier	Catalog #	Price
Volumetric flask	100ml with snap cap, Class A, 6/cs	Fisher PO Box 1307 Houston, TX 77251 (800) 766-7000	10-202B	$ 111.55
Volumetric flask	250ml with snap cap, Class A, 6/cs	Fisher	10-202D	$ 137.20
Volumetric flask (amber)	100ml for light-sensitive materials, 6/cs	Fisher	10-229C	$ 223.50
Borosilicate disposable glass test tubes	16x100mm with polypropylene screw cap, 1000/cs	Fisher	14-962-26F	$ 195.00
Funnel	55mmx25mm, disposable polypropylene with short stem, 100/cs	Fisher	10-320A	$ 24.75
Scintillation vials	20ml glass, 500/cs w/polypropylene screw caps	Fisher	03-337-4	$ 127.51
Flask w/hose connector	250ml, stopper 6, 2/pk	Fisher	10-181-7B	$ 35.20
			Total Cost:	**$ 854.71**

Table A-5. Personal Protective Equipment Recommended for Chromate Field Method

Product	Description	Suggested Supplier	Catalog #	Price
N-Dex nitrile rubber gloves	Disposable, medical grade 6005PF, 100/bx	Fisher	11-388-31	$ 26.41
Lab coats	Poly/cotton blend	Fisher	18-999-942C	$ 24.50
Safety goggles	Adjustable, w/sideshields	Fisher	17-985-30A	$ 6.66
			Total Cost:	**$ 57.57**

Appendix B – Example Chromate Calculation

You sampled a sanding operation that lasted for 30 minutes using a flow rate of 2.0 lpm. After running the sample using the field chromate method, you determined an absorbance value of 1.32. The reading for the field blank was 0.201. Your calibration curve looks like this:

$$[Cr^{VI}]\ (\mu g/ml) = 0.7634(\text{Absorbance}) - 0.0917$$

STEP 1: Calculate the mass of chromate (W) collected on the sample.

$$[Cr^{VI}]\ (\mu g/ml) = 0.7634(1.32) - 0.0917$$

$$= 0.916\ \mu g/ml$$

$$W = [Cr^{VI}]\ \frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

$$W = (0.916\ \mu g/ml)\ \frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

$$W = 33.89\ \mu g$$

STEP 2: Calculate the mass of chromate (B) on the blank.

$$[Cr^{VI}]\ (\mu g/ml) = 0.7634(0.201) - 0.0917$$

$$= 0.062$$

$$B = [Cr^{VI}]\ \frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

$$B = (0.062\ \mu g/ml)\ \frac{(10\,ml)(11.1\,ml)}{(3\,ml)}$$

$$B = 2.28\ \mu g$$

STEP 3: Calculate the chromate air concentration.

$$C = \frac{(W - B)}{V}$$

$$C = \frac{(33.89 - 2.28)}{(60)}$$

$$C = 0.527 \text{ mg/m}^3$$

The measured air concentration is 0.527 mg/m^3.